

Deanna Ruffer

From: Ryan Bennett
Sent: Wednesday, March 23, 2016 11:50 AM
To: Ryan Bennett
Cc: Deanna Ruffer
Subject: EDC - Hazard Mitigation Plan Update

Follow Up Flag: Follow Up
Due By: Wednesday, March 23, 2016 5:02 PM
Flag Status: Flagged

Members of the EDC,

I recently learned that the Town of Chatham has had an active PDM/MHM Plan in place since 2004, which is good news. The current plan is set to expire this June, 2016. A current round of grant funding through the Pre-Disaster Mitigation (PDM) and Flood Mitigation Assistance (FMA) programs (link below) require a current FEMA certified plan as a condition of eligibility at the time of grant application. In short, the Town may apply for a grant under the current solicitation, but will need to begin the MHM Plan update process sooner than the late Summer/Fall I had previously mentioned during my February 29th briefing to avoid a significant lapse in the plan's certified status. If the EDC is interested in appointing a member to the working group to help facilitate the plan update, a request for appointment may come sooner than expected.

I have unearthed both the previous and current plans and intend to make them available on the Town's website shortly.

<http://www.mass.gov/eopss/agencies/mema/resources/grants/>

Feel free to touch base with any questions/concerns.

Best,
Ryan

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Kindly remember that the Secretary of State has deemed most email a public record.



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Department of
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MEMORANDUM

TO: Economic Development Committee

FROM: Ryan Bennett, Principal Planner

DATE: February 5, 2016

SUBJECT: Requested Sea Level Rise Information for Chatham

At the December 14, 2015 Economic Development Committee meeting, and per the Committee's request, Community Development staff presented several tools used to identify potential impacts from sea-level rise. The Committee asked staff to make a formal request for the Chatham specific data from the Cape Cod Commission's sea level rise mapping application in order to help identify a local climate initiative. This memorandum contains the results from that data request, and suggestions for the Committee's consideration moving forward.

Assuming a 1' sea level rise scenario, the following vulnerabilities were identified:

- 1,789 acres of land within the Town of Chatham would be submerged (17% of Town)*
- 0.37 miles of roadway would be submerged (0.2% of roadways within Town)
- 3.8 miles of roads would be isolated, or cut-off (2% of roadways within Town)
- Under a Category 1 hurricane, 2,382 acres of land could be submerged**

The following critical facilities were identified as being intersected (but not entirely inundated) by 1' of sea level rise:

- Ryder's Cove Boatyard
- Frost Fish Creek Route 28 Bridge
- Chatham Fish Pier
- Pease Boat Works and Marine Railway
- Outermost Harbor Marine
- Stage Harbor Marine
- Chatham Harbor Master
- Oyster River Boat Yard
- Chatham Yacht Basin

The geospatial results (above) from the SLR application were slightly more compelling than the economic results. For example, only 4 businesses with a sales volume of \$245,000 were shown

*Monomoy land area is not included in this number.

**Army Corps of Engineers Sea, Lake & Overland Surge from Hurricanes (SLOSH) Model

to be impacted under a 1' SLR scenario. This is likely the result of coarse regional economic data (which clearly doesn't include marinas and boatyards). A local planning effort, which could include a survey of businesses in or adjacent the floodplain, may produce more accurate results.

Staff suggests it would be beneficial for the Town of Chatham to develop a Multi-Hazard Mitigation (MHM) Plan, where sea-level rise and other climate change related impacts are considered. Staff further supports the approach other municipalities have used to develop plans, including the establishment of a working group composed of representatives from a range of town boards, commissions and committees as well as municipal staff to oversee plan development. The EDC may wish to consider sponsoring that effort in partnership with the Community Development Department and appoint a member to be part of the working group assembled to oversee plan development, or discuss an alternative approach to accomplishing this work.

*Monomoy land area is not included in this number.

**Army Corps of Engineers Sea, Lake & Overland Surge from Hurricanes (SLOSH) Model

Deanna Ruffer

From: Ryan Bennett
Sent: Tuesday, December 15, 2015 12:57 PM
To: Ryan Bennett
Cc: Deanna Ruffer; coryjmetters@gmail.com
Subject: Climate Resources Follow-up

Dear EDC Members,

I appreciate the opportunity to introduce a few ideas for the committee's consideration in identifying a local climate change initiative. The resources I touched on last night are listed below and perhaps a good place to start with development of a local climate risk and vulnerability assessment; however, it is a lot of information to process and a fairly resource intensive planning effort. Building on current regional and state planning programs would help expedite the effort. I'd be happy to return to the EDC and help you navigate your interests in exploring this area further. In the meantime, we will make the formal request for the Chatham specific data from the CCC Sea Level Rise viewer to help give this issue a local context and a basis for moving forward. Please don't hesitate to contact me with additional questions or concerns. -- Ryan

1. Cape Cod Commission Sea Level Rise Application: <http://www.capecodcommission.org/sealevelrise/>

This tool identifies critical facilities potentially vulnerable to sea level rise and quantifies the impacts to those facilities under different sea level scenarios. It is a "bathtub model" and therefore not reflective of impacts erosion may have in changing our coastline while sea level rise is gradually occurring, or when combined with storm events. This tool also does not include a timescale. It is up to each community to make an informed decision about when these changes may occur and then assess the risk under that scenario (see next resource for guidance).

2. Planning for Sea Level Rise, CZM 2013 Guidance Document:

<http://www.mass.gov/eea/docs/czm/stormsmart/slr-guidance-2013.pdf>

A guidance document to help coastal communities and others plan for and address potential sea level rise effects on residential and commercial development, infrastructure and critical facilities, and natural resources and ecosystems. The document includes background information on local and global sea level rise trends, **summarizes the best available sea level rise projections, and provides general guidance in the selection and application of sea level rise scenarios for coastal vulnerability assessments, planning, and decision making** for areas that may be at present or future risk from the effects of sea level rise. The document is intended to be updated as new science and information becomes available.

3. NOAA Historic Sea Level Rise Trend, Wood Hole Tidal Station:

Shows the rise in Mean Sea Level since 1900 (approx. 1').

http://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?sessionId=F24B7AC2358C607D81247A80BB7B6788?s_tnid=8447930

4. Sea, Lake & Overland Surge from Hurricanes (SLOSH) storm surge inundation viewer:

The Army Corps of Engineers developed the SLOSH model, which depicts where storm surge from different category hurricanes may have the most significant landward impacts. This tool shows an older version of the model (left), compared to a newer version with better data (right) in a swipe screen function. (note: this model not effective at depicting storm surge from Nor'easters, which approach the region from a different direction and are more common on Cape Cod)

<http://cccommission.maps.arcgis.com/apps/StorytellingSwipe/index.html?appid=37d30e8410ff44489c49597f775d4aa4&webmap=a8cf418904754dcebc584cbbd25419fd#>

5. Mass CZM Shoreline Change Project

An overview of the Shoreline Change project, and directions for using the shoreline change online browser with link.
<http://www.mass.gov/eea/agencies/czm/program-areas/stormsmart-coasts/shoreline-change/>

6. Massachusetts Coastal Erosion Commission (2015 Report):

<http://www.mass.gov/eea/docs/czm/erosion-commission/cec-final-report-dec2015-v1.pdf>

7. Multi-Hazard Mitigation Planning:

The Cape Cod Commission facilitates the development of these plans for local communities. Once the plans are approved by FEMA, communities are eligible for Federal grant programs for hazard mitigation. We will be requesting CCC assistance in developing a plan for Chatham.

<http://www.capecodcommission.org/index.php?id=471&maincatid=466>

Kind Regards,

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Deanna Ruffer

From: Mike Gorman <mike@mahigold.com>
Sent: Monday, December 14, 2015 11:56 AM
To: Deanna Ruffer
Subject: EDC 11/14

Hi Deanna,

I was wondering if you could share the following links with the other members of the committee?

Thank you

-Mike

NOAA Sea Level Rise and Coastal Flooding Impacts - <http://go.usa.gov/cKRhZ>

"North Carolina government eventually passed a law banning coastal policymakers from using accelerated sea-level rise predictions to make decisions for their communities." - <http://www.businessinsider.com/5-terrifying-impacts-of-rising-sea-levels-2015-2>

Boston Living With Water - <http://www.bostonlivingwithwater.org/wp-content/uploads/2015/01/Designing-with-Water-Creative-Solutions-from-Around-the-Globe-Aug-2014.pdf>

Cape Cod Time Article 12/11/15 - <http://www.capecodtimes.com/article/20151211/NEWS/151219886/101281>

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From: Deanna Ruffer
Sent: Thursday, December 10, 2015 11:56 AM
To: 'Bates, Luther'; 'Cory Metters (cmetters@hotmail.com)'; 'Darren Saletta (freemonomoy@gmail.com)'; 'George Khalil (gtcoogee@me.com)'; 'Jill Goldsmith'; 'Mike Gorman'; 'Stephen Buckley'; 'Walter Bush (wltr.bush@gmail.com)'
Cc: Ryan Bennett
Subject: Background Materials for Monday (Dec 14th) EDC Meeting

EDC Members, the Chairman has asked compiled the following reference materials for your review in advance of next Monday's (Dec 14th 6PM Annex Small Meeting Room) EDC meeting:

https://www.cambridgema.gov/~media/Files/CDD/Climate/climateplans/climate_adaptation_recs_20100405.pdf

"The document outlines the basis for the committee's sense that 1) there are risks related to climate change that the city may face and that 2) these risks are sufficiently plausible, although uncertain, that the city should begin to identify the range of potential risks, study their likelihood, timing and consequences, and, for some, develop and prioritize strategies for addressing them and/or their consequences. In short, the Committee suggests that the City assess our vulnerabilities."

<http://www.dnrec.delaware.gov/coastal/Pages/DESLRAAdvisoryCommittee.aspx>

<http://www.dnrec.delaware.gov/coastal/Pages/SLR/DelawareSLRVulnerabilityAssessment.aspx>

<http://www.cambridgema.gov/CDD/Projects/Climate/climatechangersilienceandadaptation.aspx>

<http://www.hingham-ma.gov/conservation/climate.html>

Please let me know if you'd like me to bring a hard copy for you to the meeting on Monday.

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Woods Hole Sea Grant Program
Cape Cod Cooperative Extension



The Effect of Sea Level Rise on the Barrier Beaches of Cape Cod, Martha's Vineyard, and Nantucket

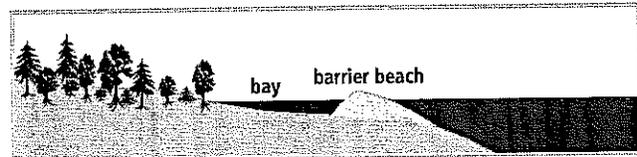
In Massachusetts a barrier beach is defined by the state Wetlands Protection Act (310CMR10.29) as a narrow low-lying strip of land generally consisting of coastal beaches and coastal dunes. According to the CZM Barrier Beach Inventory Project there are ~680 designated barrier beaches in Massachusetts, ~460 (70%) are on the Cape and Islands. They are typically separated from the mainland by a narrow body of water or a marsh system (Figure 1). A barrier beach may be joined to the mainland at one or both ends, while a barrier island is separated from the mainland.

The dynamic nature of barrier beaches protect landward areas providing a buffer to storm waves and storm surge. Barrier beaches protect upland private property as well as salt marshes, estuaries, salt ponds, etc., which are essential to juvenile marine fisheries. In addition, these beaches are also important to the protection of upland wildlife habitat and productive shellfish beds. Barrier beaches are also some of the locations most favored by locals and tourists alike and bring significant income to the economy.

Although barrier beaches may seem relatively stable, they are constantly changing. Some people may wonder if barrier beaches can survive the effects of sea level rise, or will simply disappear. This bulletin describes how barrier beaches are formed and how they respond to the forces of sea level rise, tides and storm events. This understanding will help us to know what barrier beaches might look like in years to come and whether there are steps we can take now to preserve barrier beaches.



Figure 1. Aerial photograph of the barrier beach protecting Pleasant Bay taken near Nauset Beach (Orleans) looking south.



System migrates landward across the shelf as sea level rises.



If the system did not migrate it would be submerged by the rising sea level.

Figure 2. Sea level rise has been occurring for thousands of years. During this time barrier beaches have migrated landward through natural coastal processes and have avoided "drowning in place".

Geological History

Most of the barrier beaches on Cape Cod and the Islands are "transgressive," migrating landward and upward (in the long term) and cover the water body or salt marsh that lies behind it (Figure 2). This process has been occurring on most beaches on Cape Cod and the Islands for thousands of years. The driving mechanisms behind this shoreline movement are sea level rise and occasional storm events. Sea level has been rising globally since the end of the last ice age when glaciers started melting more than 20,000 years ago. (Fairbanks, 1989). During this time when a significant amount of water was sequestered in the glaciers, sea level was ~450 feet lower than it is today and our ocean coastline was ~100 miles offshore of its present position land (see left panel of Figure 4). The added water forced the shoreline to move up the gently sloping continental shelf. Eleven thousand years ago there were no glaciers in the immediate area, but there were still very large glaciers on land further north. During

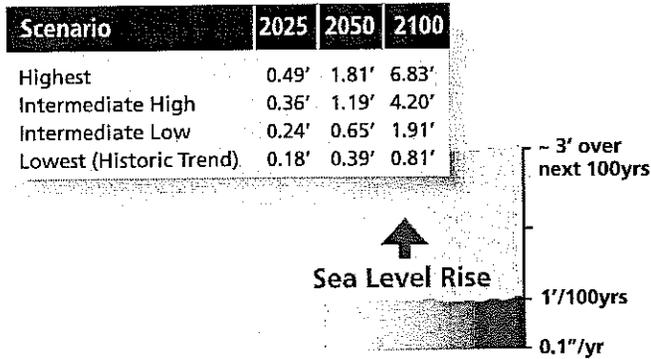


Figure 3. Relative sea level rise estimates adjusted to account for local vertical land movement for Boston, MA. This may match Woods Hole as well, but may underestimate Nantucket (from CZM, 2013).

this time period Georges Bank was not yet submerged and was connected to Cape Cod and the Islands by land (see Figure 4). As the climate continued to warm and ice in the northern glaciers melted, water poured back into the ocean and sea level rose. Approximately 6,000 years ago Georges Bank was inundated and much higher wave energy was now able to strike outer Cape Cod. These stronger waves accelerated erosion of the coastal bluffs, pulling sand away from the mainland and depositing it as barrier beaches across Pleasant Bay and Monomy, in addition to building up Provincetown out of the sea.

The Effects of Sea Level Rise

Along the coastline of Cape Cod and the Islands, sea level is not only rising, the land is also slowly sinking (aka subsiding) due to geologic processes. The rise in the water level that takes into account local effects (subsidence, currents, etc.) with global sea level is known as relative sea level rise. In our area, the average rate of relative sea level has been about a tenth of an inch per year, or about one foot per century (Figure 3). Most of these changes in relative sea level are only significant on a large scale (e.g., state vs state), however even between Woods Hole and Nantucket there is a small (0.25"/100 years) measureable change.

While there are a wide range of sea level rise projections, the state has provided guidance of a relative increase of around 3' by 2100 (range = 0.8–6.8', median = 3', see Figure 3 CZM, 2013). On time scales of hundreds to thousands of years, increased sea level rise could accelerate the migration of barriers landward or even lead to their

disappearance altogether if the rise is very fast. The projected increases in sea level could make sections of the ocean coast more vulnerable to erosion over time. However, over typical planning time frames of 30 to 50 years, even increased sea level rise would not significantly change the actual observed rates of shoreline change in those areas experiencing the most severe erosion. On these time scales, sea level rise is of secondary importance compared to other factors in controlling what happens on the coast. On longer time scales and less rapidly eroding shorelines sea level rise has a more dominant impact. The frequency and intensity of coastal storms, and interruptions in the supply of sand available for building the beaches play a greater role (in the short to mid term) in shaping the coast. In most cases, our most severe erosion problems are caused by disruptions in the transport of sand, due to either natural processes or human activities (such as the building of seawalls).

Barrier Beaches — Creation and Migration

The original source of the sand that forms our barrier beaches is from erosion and transport of materials deposited by glaciers thousands of years ago. As sand is deposited in nearshore areas, the combination of wind, waves, and currents distribute sand along the coastline.

There are many mechanisms of dune and barrier beach formation; the one most applicable to our area is spit migration. Barrier beach formation by spit migration is a result of sediment (i.e., cobbles, sand, silt) being transported by waves and currents along the shore, and the progressive deposition of sand resulting in the elongation of a spit of land or dune line, parallel to the shore. A marsh or water body then develops between the mainland and the developing dunes. Tidal inlets often develop along with barrier beaches. These inlets are the pathway for seawater to move back and forth between the near-shore ocean and the back-barrier bays and marshes. Tidal inlets can be transitory environments which may move along a shore at highly variable speeds (Figure 5). The movement of sand along the beach tends to accumulate sand on the updrift side of the inlet and remove sand from the down-drift side, thereby typically forcing the inlet to migrate in the direction of longshore transport.

These barrier beaches retreated (migrated landward) as the ocean continued rising (Figure 6). There are three primary ways that sand can be transported across barrier beach: inlet formation, overwash processes and eolian (or wind) transport. Overwash fans and flood tidal shoals (created by historical inlets) provide the platform that allows the barrier beaches to maintain themselves while moving landward over time in response to rising sea level (Figure 7). Regardless of



Figure 4. The green area in the three maps above indicates an exposed land mass. Over geologic time, the shoreline has retreated landward over the last 18-20,000 years as the glaciers melted and sea level rose. (Adapted from Shaw et al., 2002)

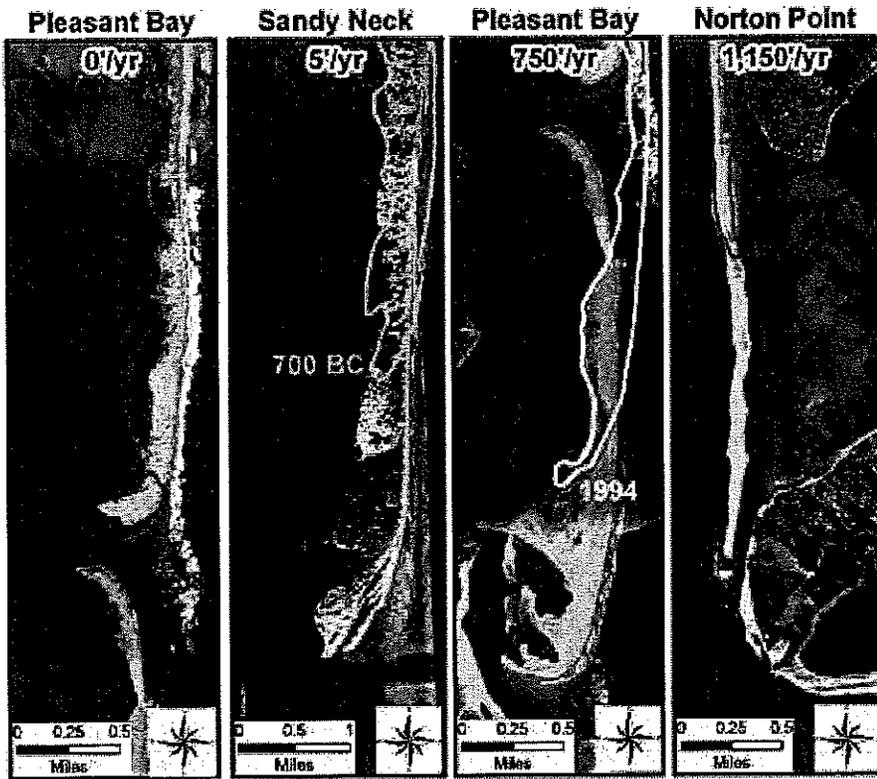


Figure 5. Sediment being transported along the beach drives the tip of the barrier, and thereby the inlet to migrate. The rate at which the barriers migrate varies due to the volume of sand being transported and wave environment. Examples shown above range from 0'/yr at the 2007 inlet of Pleasant Bay in Orleans, to 5'/yr at Sandy Neck in Barnstable, to 750'/yr at the 1987 inlet of Pleasant Bay in Chatham, to 1,150'/yr at Norton Point in Edgartown.

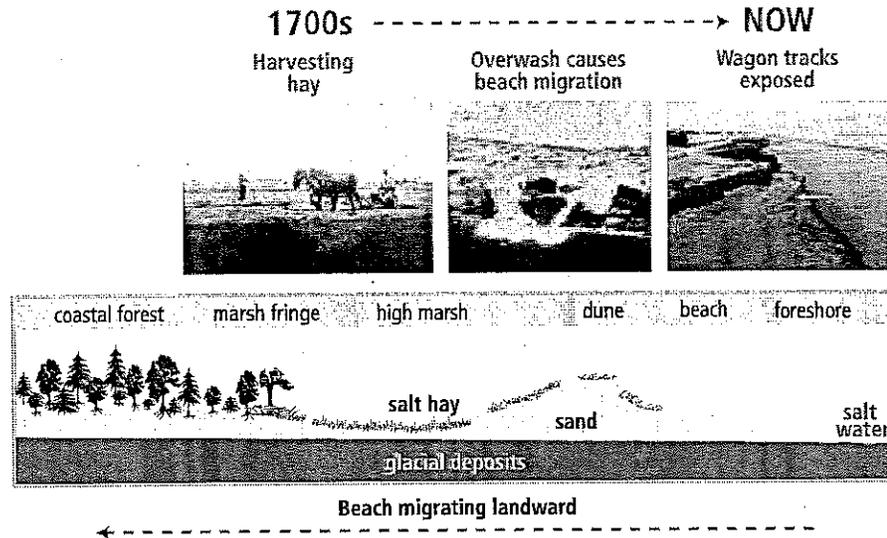


Figure 6. Most of our beaches are "transgressive," which is defined as a beach migrating landward and upward (in the long term) and covering the water body or salt marsh that lies behind it. One example of evidence of this migration is wagon tracks observed in peat exposed at the foreshore beach. Hundreds of years ago salt hay was harvested by wagon in marshy areas landward of the dune, and the barrier beach migrated these areas got covered (typically by the transport of sediments over the beach and dune system by storm waves which deposits a fan of sediments on the landward side aka overwash) until erosion exposed these tracks in their current environment. "Harvesting Hay" photograph from *Sand Dunes and Salt Marshes*, by Charles W. Townsend (1913).

the actual mechanisms by which the barriers move in response to the rise in sea level, they have moved landward over the historical time frame of thousands of years.

How Management Practices Affect Barrier Beaches

The coastline of Cape Cod and the Islands is a remarkably diverse and complex place. It is this diversity and complexity that provide the many environmental, recreational and economic benefits the coast has to offer. This area is also very dynamic and, in many ways, very fragile. The shoreline we value and enjoy today was created by a variety of forces and processes operating on time scales ranging from hours to millennia. The result is a coastline that is naturally changing all the time.

Proper management of this important area requires a solid understanding of the factors affecting shoreline, how the shoreline responds to these factors, and the desired uses of the area. *Guidelines for Barrier Beach Management in Massachusetts*. A report of the Massachusetts Barrier Beach Task Force, CZM, 1994, was designed as a reference tool for those charged with the responsibility of preparing, reviewing, and implementing barrier beach management plans. Some have attempted to alter barrier beach inlet systems with limited success. In 2007, during the same Patriot's Day storm that opened the second inlet of Pleasant Bay, a new inlet formed in the barrier beach connecting Katama Bay to the Atlantic Ocean. This natural opening closed with no intervention in 2015, however historically this area has seen multiple attempts at significant human intervention. The first (of many) known attempts to open occurred in 1873, in order to "refresh the bay for shellfish" and for commercial fishermen to have a shortcut to Wasque Point, at the eastern end of Chappaquiddick. It was quickly closed by a storm. Only one failed attempt was made to artificially close the inlet. In 1976, cranes and bulldozers piled up dunes and sandbags to try to plug the inlet. This was attempted in order to stop the shifting sand from burying shellfish beds and to reduce the wild currents in Edgartown Harbor. After four months of attempts they gave up, and a year later the inlet closed natu-

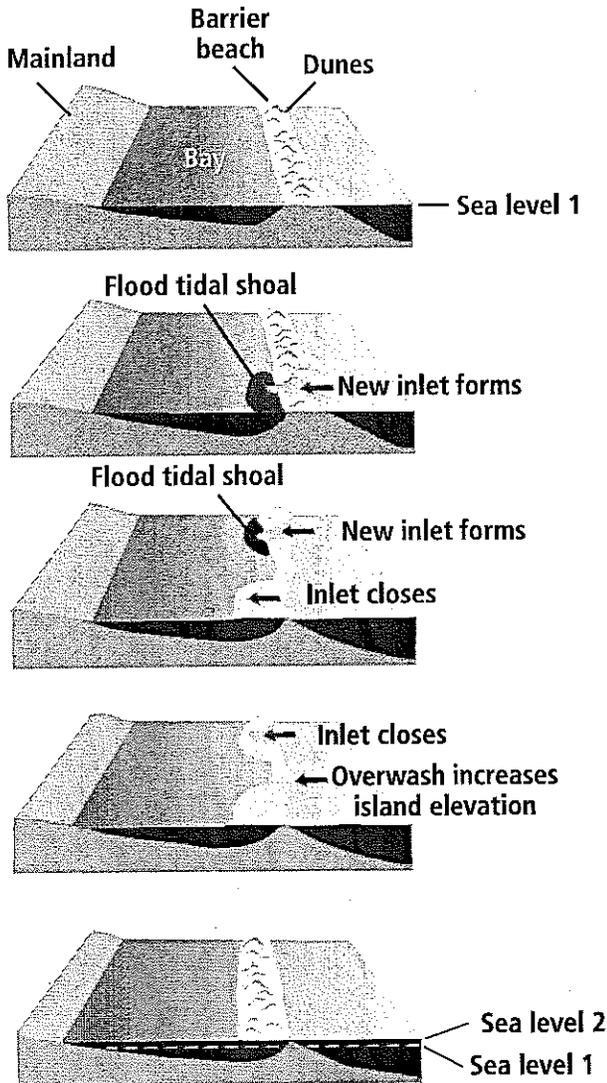


Figure 7. Simplified schematic of barrier island migration in response to sea level rise. Inlets transport sand to bays in the form of flood tidal shoals which provides the platform that allows the island to move landward. Overwash processes then raise the elevation of the island. This migration is a slow process occurring over periods of hundreds to thousands of years. (Illustration adapted from John Norton in Tanski, 2012)



Woods Hole Sea Grant

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rally on its own (*Man's Efforts to Open – and Close – Norton Point*, Tom Dunlop, *Martha's Vineyard Magazine*, 5.1.11).

In some areas, the best management strategy may be to do nothing and let the natural processes continue unimpeded. The Cape Cod National Seashore manages a portion of the barrier beaches and islands protecting Pleasant Bay and has a strict ban on human intervention (coastal engineering structures, sand nourishment, inlet relocation, etc.). These types of invasive beach management are not allowed by National Park Service policies, which require the preservation of natural processes, including erosion, overwash, deposition, inlet formation, and shoreline migration.

While some intervention may be warranted, whatever management strategy is employed, efforts to mitigate erosion problems should work in concert with, and not against, natural processes. Management strategies need to be adaptable to changing conditions to ensure preservation for future generations.

Helpful References:

- Davis, R.A., Jr., 1992. *Depositional systems: An introduction to sedimentology and stratigraphy*. Prentice Hall, Englewood Cliffs, NJ.
- Fairbanks, R.G., 1989. A 17,000-year glacio-eustatic sea level record: influence of glacial melting rates on the Younger Dryas event and deep ocean circulation. *Nature*, 342, 637–657.
- Komar, P.D., 1983. *Beach processes and erosion, an introduction*. In: *Handbook of coastal processes and erosion*. CRC Press, Boca Raton, FL.
- Oldale, R.N., *Geologic History of Cape Cod, Massachusetts*. USGS. <http://pubs.usgs.gov/gip/capecod/>
- *Sea Level Rise: Understanding and Applying Trends and Future Scenarios for Analysis and Planning*, Coastal Zone Management (CZM), December 2013.
- Shaw, J, Gazeau, P, and Courtney RC (2002) *Palaeogeography of Atlantic Canada 13-0kyr*. *Quaternary Science Reviews*, 21:1861-1878.
- Tanski, J. 2012 (revised). *Long Island's Dynamic South Shore — A Primer on the Forces and Trends Shaping Our Coast*. New York Sea Grant. 27 pages.

Additional information:

- <http://tidesandcurrents.noaa.gov/sltrends/sltrends.html>
- www.mass.gov/eea/docs/czm/stormsmart/slr-guidance-2013.pdf
- <http://www.mass.gov/eea/agencies/czm/program-areas/stormsmart-coasts/barrier-beaches/>

Acknowledgements:

This brochure would not have been possible without support and input from numerous individuals, including Rebecca Haney (Massachusetts CZM), John Jannell (Town of Orleans), Shannon Jarbeau (Cape Cod Cooperative Extension), and the many helpful comments by the Pleasant Bay Alliance Coastal Processes and Structures Work Group. Portions of *Long Island's Dynamic South Shore* (by Tanski, 2012 – New York Sea Grant) have been adapted and included in this bulletin with the generous permission of the author. Financial support for the this project was generously provided by Woods Hole Sea Grant (NOAA Award NA14OAR4170074, publication no. 15-201) and the Barnstable County Cape Cod Cooperative Extension. The Pleasant Bay Alliance generously assisted with hardcopy printing costs.